GUADALUPE RIVER 2018 ADULT SALMONID MIGRATION MONITORING USING THE VAKI RIVERWATCHER PASSIVE MONITORING SYSTEM

January 30, 2018 - May 31, 2018

Prepared by:

Santa Clara Valley Water District

Environmental Mitigation and Monitoring Unit

January 30, 2019

Contents

INTRODUCTION .... - 1 -
INSTALLATION, MAINTENANCE, AND METHODS .... - 1 -
RESULTS .... - 3 -
DISCUSSION .... - 6 -
WORKS CITED .... - 8 -

List of Figures

Figure 1: Number of detections of each fish species throughout the Guadalupe River Vaki deployment period. .... - 4 -
Figure 2: O. mykiss detections per day in relation to cubic feet per second daily averages on the Guadalupe River stream gage ALERT 5023b above Almaden Expwy. .... - 5 -
Figure 3: Adult O. mykiss estimated length and date of migration (adult O. mykiss were identified as fish greater than 350 mm). .... - 6 -
Figure 4: Images of adult *O. mykiss* captured by the Vaki RiverWatcher. A 610 mm total length (left) moving downstream and 380 mm total length (right) moving upstream. .... - 6 -

List of Tables

Table 1: Total *O. mykiss* detections based on age classification and direction of movement. .... - 4 -

INTRODUCTION

Steelhead (*Oncorhynchus mykiss*) in the Central California Coast (CCC) Distinct Population Segment (formerly Evolutionarily Significant Unit) were listed as threatened by the National Marine Fisheries Service (NMFS) in 1997. Due to their protected status, the Santa Clara Valley Water District (SCVWD) decided to implement a noninvasive means of documenting steelhead passage through the fishways. The equipment chosen to accomplish the task was the Vaki Riverwatcher (Vaki), a computer-based fish counter which employs scanner plates and a digital camera to capture videos and silhouette images of fish as they pass between the plates. The Vaki provides information on the occurrence and timing of fish migration both upstream and downstream of the counter.

The Alamitos fish ladder is located 32 kilometers upstream of the South San Francisco Bay on the Guadalupe River between Coleman Road and Blossom Hill Road, just downstream of Almaden Lake in San Jose, California. The fish ladder was installed in November 1999 at the Alamitos Drop Structure, a 13-foot tall structure that had previously created an impassable barrier to fish migration. The installation of the Alamitos Fishway opened up an additional 27 kilometers of upstream habitat for migrating fish. The Vaki was first deployed in the most downstream weir of the Alamitos Fishway for three monitoring seasons (years 1-3) from 2003 to 2006.On January 30th, 2018, the Vaki was reinstalled at the Alamitos fish ladder for a fourth season of monitoring following a 12-year break at this location; the 2018 monitoring year will be the focus of this report. The Vaki provided documentation of anadromous fish passage through the Alamitos Fishway, confirming that the fish ladder afforded passage for salmonids around the drop structure, providing seasonal continuity of fish passage in the Guadalupe system from the San Francisco Bay to upstream tributaries.

INSTALLATION, MAINTENANCE, AND METHODS

The Vaki was installed on January 30, 2018. This is later in the season than originally intended, as installation was delayed due to unforeseen complications with fabrication and implementation. Initially, the Vaki was unintentionally and unknowingly installed approximately 0.3 meters above the bottom of the channel due to a piece of woody debris sitting on the bottom of the channel. This allowed for fish to pass under the counter and not be recorded by the system. The issue was resolved on March 6, 2018 by removing the wood and lowering the Vaki to sit flush on the bottom of the channel.

The counter itself is a rectangular-shaped unit outfitted with infrared light emitting diodes on the interior and is completely submerged underwater within the fish ladder. Adult fish are directed through the counter opening by use of weirs in the ladder, and when it swims through the counter and breaks the plane of light beams, the fish is scanned and a resulting silhouette image is sent to the onsite computer. Other information recorded as the fish passes includes the speed the fish was traveling, the direction the fish was moving (upstream or downstream), the body depth of the passing fish (for depth to length ratios), along with the date and time. A fish detection then triggers an underwater digital camera which records a 4.1 second video for fish traveling upstream or a 14.4 second video for fish traveling downstream. This enables the user to scan through the videos to confirm the presence of a fish and improves confidence in species identification. All the data collected by the Vaki are stored by the attached onsite computer. Data is manually downloaded twice per week and stored on the SCVWD network. The files are manually vetted as soon as possible.

The Vaki was maintained and cleaned twice a week by removing debris and algal build up on the scanner plates and plexiglass in front of the camera with a Mr. Long Arm brush. Data was manually downloaded from the onsite database, which was reset during each of these checks.

Because this Vaki runs off solar power, there were a few instances after several cloudy and rainy days where the battery reserve would drop so low that the Vaki would only record a silhouette image for each detection with no accompanying video. The Vaki completely lost power due to this same issue on the nights of March 22 and 23, 2018, but it was restarted the morning on March 24. The Vaki also had a brief 3-hour cessation on March 6, 2018 when the large woody debris beneath the Vaki was removed. One factor that must also be considered is that during the time of cleaning fish can still move up and down through the system and they will not be detected by the Vaki. It is a brief window, but there is a potential that migrating fish could be missed during cleaning and maintenance. These are all periods that migrating fish could have been missed.

The Vaki records silhouettes and videos off all items large enough to break the plain of the diodes. Scanned infrared silhouettes and video images were reviewed to ensure that only fish passage events were included in the overall passage counts. Video images were used to identify fish to species when conditions provided clear images. Silhouettes can also be used to identify the fish to species if identifying characteristics are depicted. Detections without videos were only sorted into specific species categories if the silhouette was particularly clear and the confidence level was high, otherwise these detections were sorted into the “unknown fish” category. Length to depth ratios were used to estimate the length of a specific individual based upon their body depth as detected by the Vaki. The length to depth ratios for *O. mykiss* were 4.1:1 for small and medium fish (<300 mm) and 4.8:1 for large fish (Cuthbert et al. 2012).

Steelhead with a standard length greater than 350 mm were classified as adult *O. mykiss*, while anything 350 mm and below were determined to be juveniles (Moyle, 2002). The scanner plates trigger a detection and a video recording only when a body depth of 40 mm or greater is detected. This results in a lack of detection for *O. mykiss* with an estimated fork length of 159 mm or less.

Only *O. mykiss* detections in the adult size range were analyzed to provide an estimate of the actual number of individual fish recorded. Juvenile fish could not be analyzed as their body depth could result in no detections on the Vaki and juvenile fish could travel through the weir bars limiting the ability to assess up and down movement. In attempt to reduce repeated detections of the same fish, data were analyzed using a direction, timing, and size criteria. A series of detections were considered the same fish if two or more detections occurred in an up to down or down to up pattern, were within 5 mm of body depth, and occurred within a 15-minute time period.

RESULTS

During the monitoring season, several native and non-native fish were documented passing through the Vaki. *O. mykiss*, Sacramento sucker (*Catostomus occidentalis*), common carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), *Lepomis spp.*, goldfish (*Carassius auratus*), *Pomoxis spp.,* brown bullhead (*Ameiurus nebulosus*), and prickly sculpin (*Cottus asper*) were all positively identified from the Vaki video footage and silhouettes. Examples of positive identifications can be seen in Appendix A. Unknown fish detections were instances where fish were detected, but they could not be identified to species based on the silhouette or video. There was a total of 1,109 fish detections throughout the time the Vaki was installed with *O. mykiss* being the most commonly detected fish with 355 detections (Figure 1). After *O. mykiss* detections, carp and goldfish were the second largest group of fish detected with 310 detections.

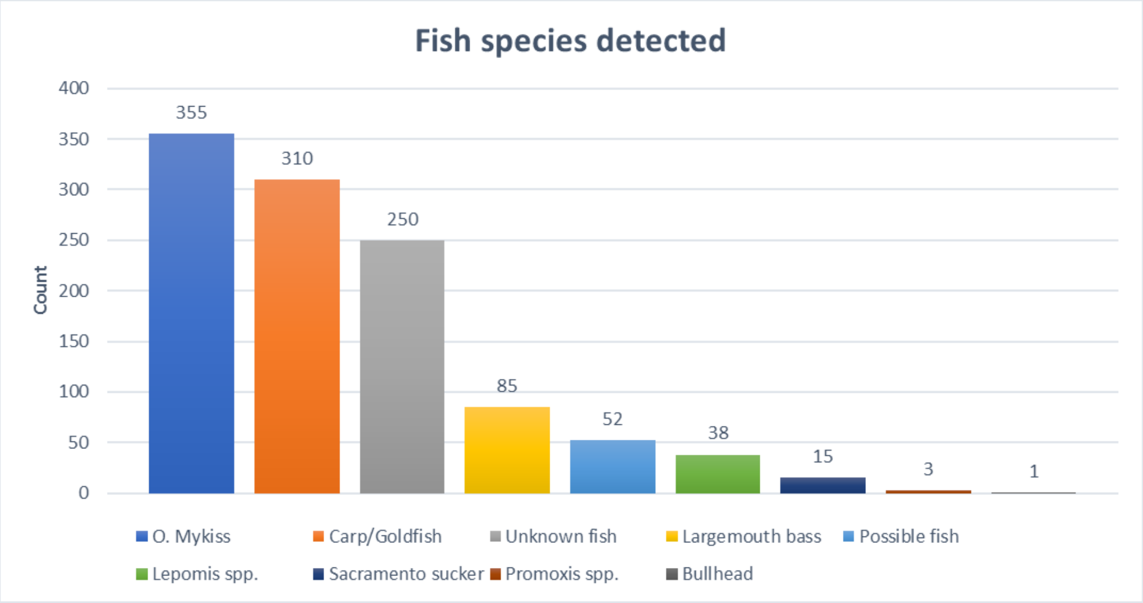


Figure 1: Number of detections of each fish species throughout the Guadalupe River Vaki deployment period.

Of the 355 *O. mykiss* detections, 167 recorded were moving upstream and 188 were moving downstream (Table 1 and Figure 2). There was a total of 31 Vaki detections classified as *O. mykiss* in the adult size range, with 14 moving upstream and17 going down. These are not individual fish but are just individual detections.

Table 1: Total *O. mykiss* detections based on age classification and direction of movement.

Age Class	Upstream	Downstream
Juvenile (≤350 mm)	153	171
Adult (>350 mm)	14	17
Total	167	188

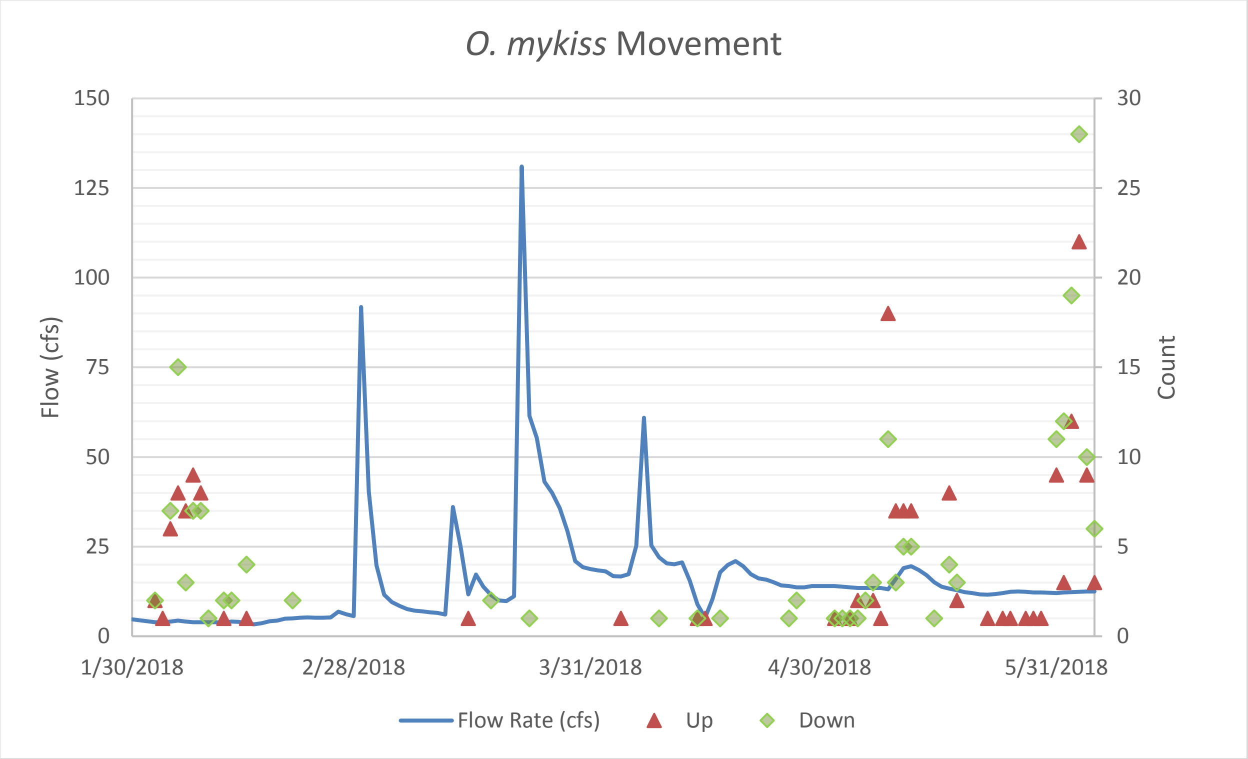


Figure 2: ***O. mykiss*** **detections per day in relation to cubic feet per second daily averages on the Guadalupe River stream gage ALERT 5023b above Almaden Expwy.**

The size range of *O. mykiss* detected ranged from 160 mm to 610 mm. The timing and estimated size of adult *O. mykiss* detections can be seen in Figure 3. The size and timing of juvenile movement was not included in this figure as it does not provide a complete picture of the movement of juvenile *O. mykiss* due to the size limitation of the Vaki software. The average estimated size of adult fish moving upstream was 388 mm and downstream was 410 mm. The three largest *O. mykiss* detected were estimated at 610 mm, 590 mm, and 580 mm and were all moving downstream (Figure 3 and 4).

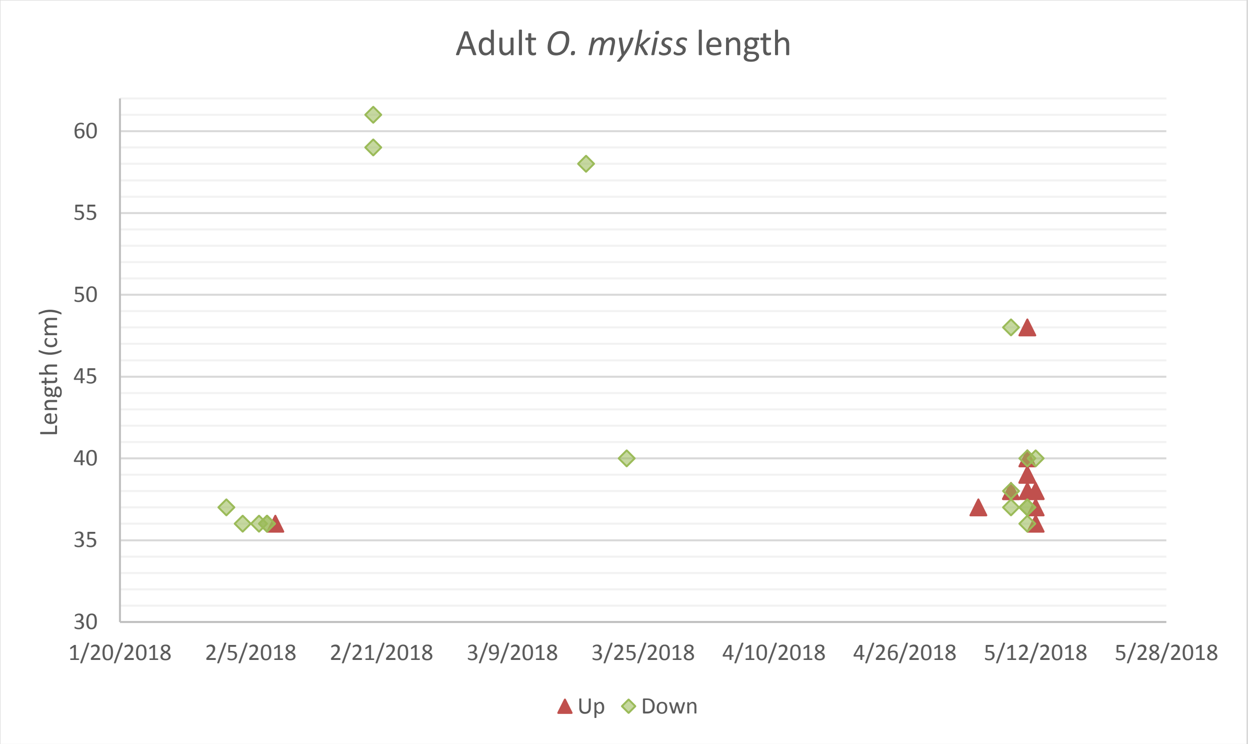


Figure 3: Adult O. mykiss estimated length and date of migration (adult O. mykiss were identified as fish greater than 350 mm).

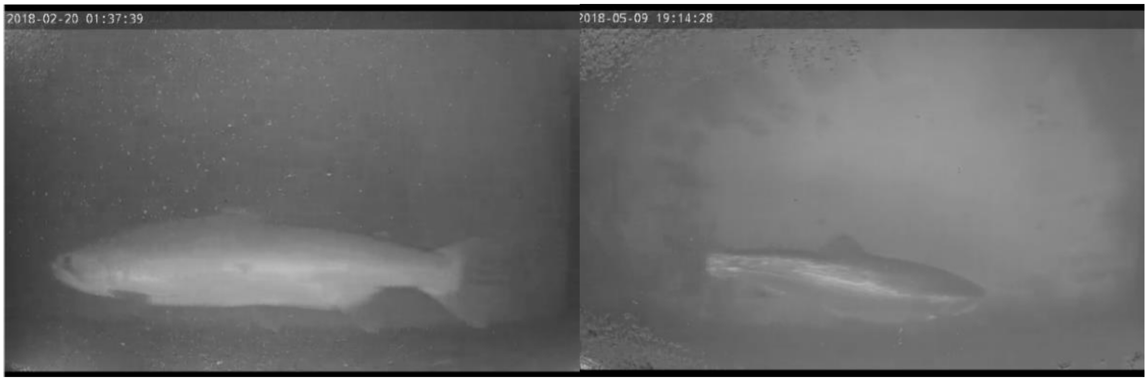


Figure 4: Images of adult *O. mykiss* captured by the Vaki RiverWatcher. A 610 mm total length (left) moving downstream and 380 mm total length (right) moving upstream.

DISCUSSION

Ideally the Vaki would have been installed by October or November to ensure capture of the entire steelhead migration season. Adult *O. mykiss* typically begin their upstream migration between December and March, peaking in January and February (Moyle, 2002). With the Vaki being installed on January 30th, two months of potential migration data was not recorded.

The data collected are particularly challenging to analyze and draw conclusions from due to the gap created in the initial install and late-season installation. The higher number of adults moving downstream versus upstream could be explained by these two issues. When the data were analyzed in attempt to reduce repeat detections the 31 adult sized range detections were reduced to 26 individuals with 14 of the fish recorded moving downstream and 12 passing upstream.

The 360 mm to 610 mm size range detected for adult *O. mykiss* is very broad. It is likely that some of the fish detections closer to the 360 mm size range are resident rainbow trout moving through the system. During the 2018 juvenile rearing monitoring conducted in the Guadalupe Watershed, the largest *O. mykiss* captured was 345 mm fork length, which would generate a total length greater than 350 mm. Only one fish in this size range was collected during that sampling effort and it made up less than 1% of the population (SCVWD 2019).

Limited movement of *O. mykiss* was observed during the large flow events (greater than 50 cfs at ALERT stream gage 5023b) that occurred in the month of March. No adult-sized fish were observed moving upstream in March or April. The concentration of *O. mykiss* observed in the beginning of February moving up- and downstream after the Vaki installation could have been the result of flow events that occurred in December and January.

The lack of Chinook salmon (*Oncorhynchus tshawytscha*) detections can be attributed to the late Vaki installation date on January 30th, which would be late for Chinook salmon migration. The 2018 abbreviated monitoring period provided more lessons learned than beneficial data. The shortcomings and technological issues that occurred in 2018 were taken into consideration for the WY 2019 monitoring. Through these experiences it is hoped that better data collection will occur moving forward.

WORKS CITED

Cuthbert, R., Cuthbert, P., and Fuller, A. (2013) Salinas River Basin Adult Steelhead Escapement Monitoring: 2013 Annual Report-Final Draft. Submitted to the Monterey County Water Resources Agency. FISHBIO, Oakdale, California.

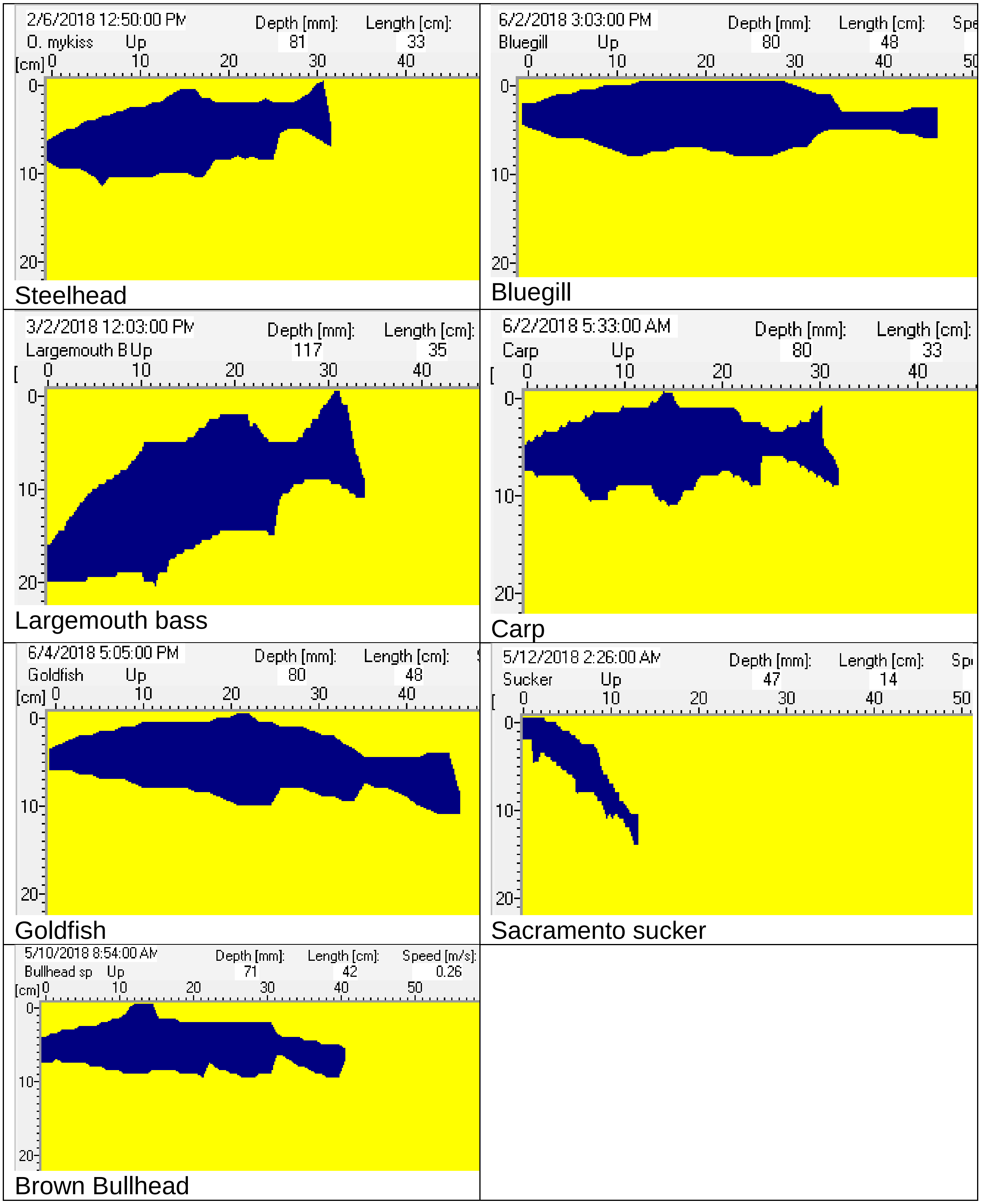
Santa Clara Valley Water District (SCVWD). 2019. Water Year 2018 Juvenile *Oncorhynchus mykiss* Rearing Monitoring in the Guadalupe River Watershed. Prepared by the Environmental Mitigation and Monitoring Unit. San Jose, CA.

Moyle, P. B. (2002). *Inland fishes of California*. Berkeley: University of California Press.

Appendix A

Sample Silhouettes and Video Imag

Fish Silhouettes



Steelhead

Bluegill

Largemouth bass

Carp

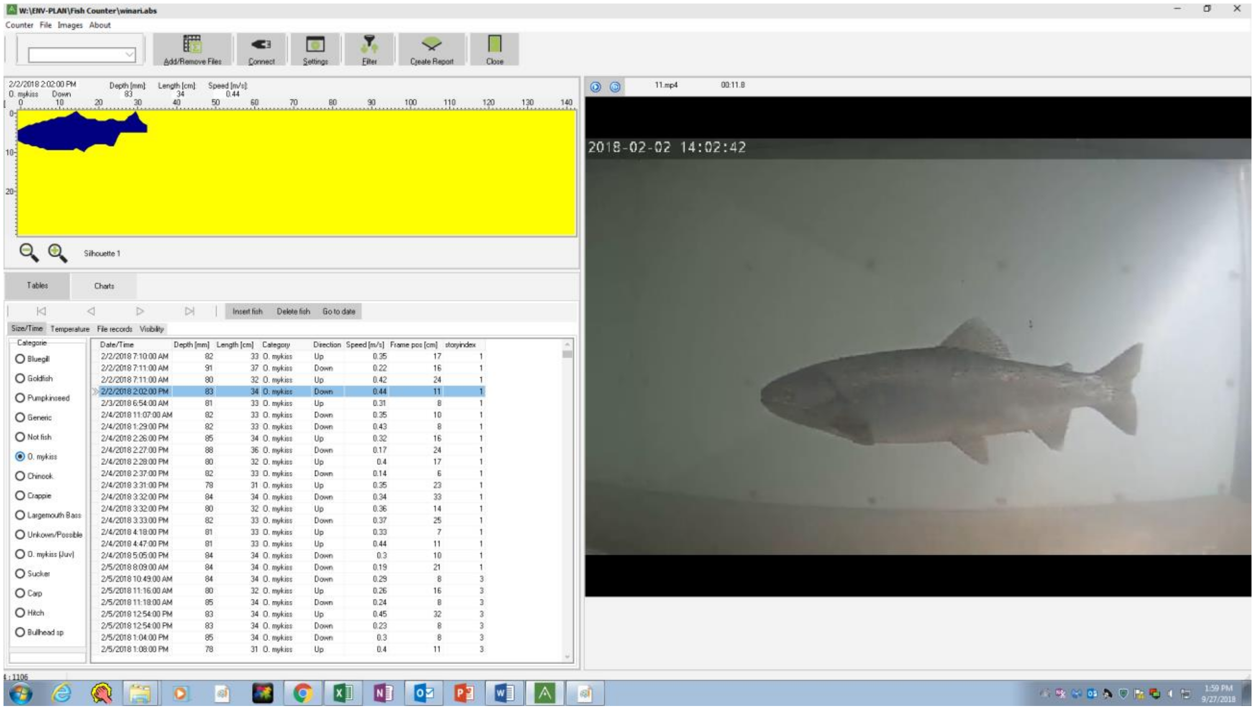
Goldfish

Sacramento sucker

Brown Bullhead

Figure 1: A sample of the silhouette images generated by the Vaki for each fish species in the report.

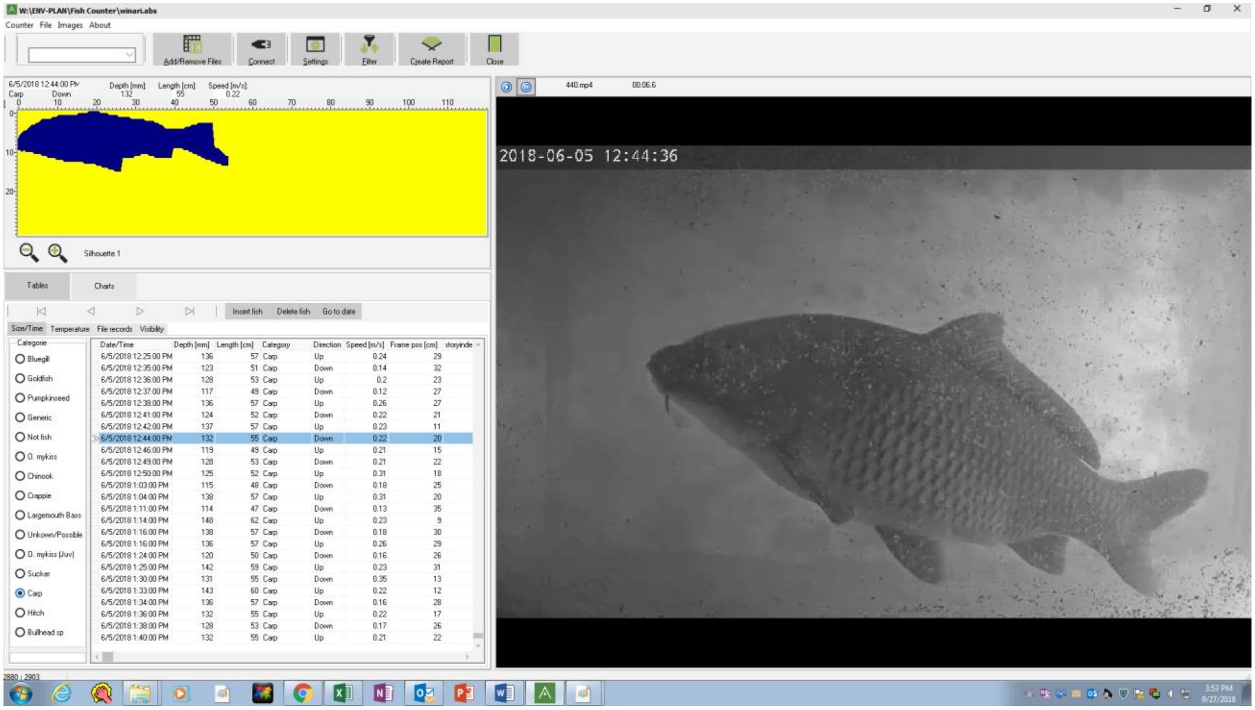
Fish Video Images



2/2/2018 2:02:00 PM
O. mykiss Down
Depth [mm]: 83
Length [cm]: 34
Speed [m/s]: 0.44

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
2/2/2018 7:10:00 AM	82	33	O. mykiss	Up	0.35	17	1
2/2/2018 7:11:00 AM	91	37	O. mykiss	Down	0.22	16	1
2/2/2018 7:11:00 AM	80	32	O. mykiss	Up	0.42	24	1
2/2/2018 2:02:00 PM	83	34	O. mykiss	Down	0.44	11	1
2/3/2018 6:54:00 AM	81	33	O. mykiss	Up	0.31	8	1
2/4/2018 11:07:00 AM	82	33	O. mykiss	Down	0.35	10	1
2/4/2018 1:29:00 PM	82	33	O. mykiss	Down	0.43	8	1
2/4/2018 2:26:00 PM	85	34	O. mykiss	Up	0.32	16	1
2/4/2018 2:27:00 PM	88	36	O. mykiss	Down	0.17	24	1
2/4/2018 2:28:00 PM	80	32	O. mykiss	Up	0.4	17	1
2/4/2018 2:37:00 PM	82	33	O. mykiss	Down	0.14	6	1
2/4/2018 3:31:00 PM	78	31	O. mykiss	Up	0.35	23	1
2/4/2018 3:32:00 PM	84	34	O. mykiss	Down	0.34	33	1
2/4/2018 3:32:00 PM	80	32	O. mykiss	Up	0.36	14	1
2/4/2018 3:33:00 PM	82	33	O. mykiss	Down	0.37	25	1
2/4/2018 4:18:00 PM	81	33	O. mykiss	Up	0.33	7	1
2/4/2018 4:47:00 PM	81	33	O. mykiss	Up	0.44	11	1
2/4/2018 5:05:00 PM	84	34	O. mykiss	Down	0.3	10	1
2/5/2018 8:09:00 AM	84	34	O. mykiss	Down	0.19	21	1
2/5/2018 10:49:00 AM	84	34	O. mykiss	Down	0.29	8	3
2/5/2018 11:16:00 AM	80	32	O. mykiss	Up	0.26	16	3
2/5/2018 11:18:00 AM	85	34	O. mykiss	Down	0.24	8	3
2/5/2018 12:54:00 PM	83	34	O. mykiss	Up	0.45	32	3
2/5/2018 12:54:00 PM	83	34	O. mykiss	Down	0.23	8	3
2/5/2018 1:04:00 PM	85	34	O. mykiss	Down	0.3	8	3
2/5/2018 1:08:00 PM	78	31	O. mykiss	Up	0.4	11	3

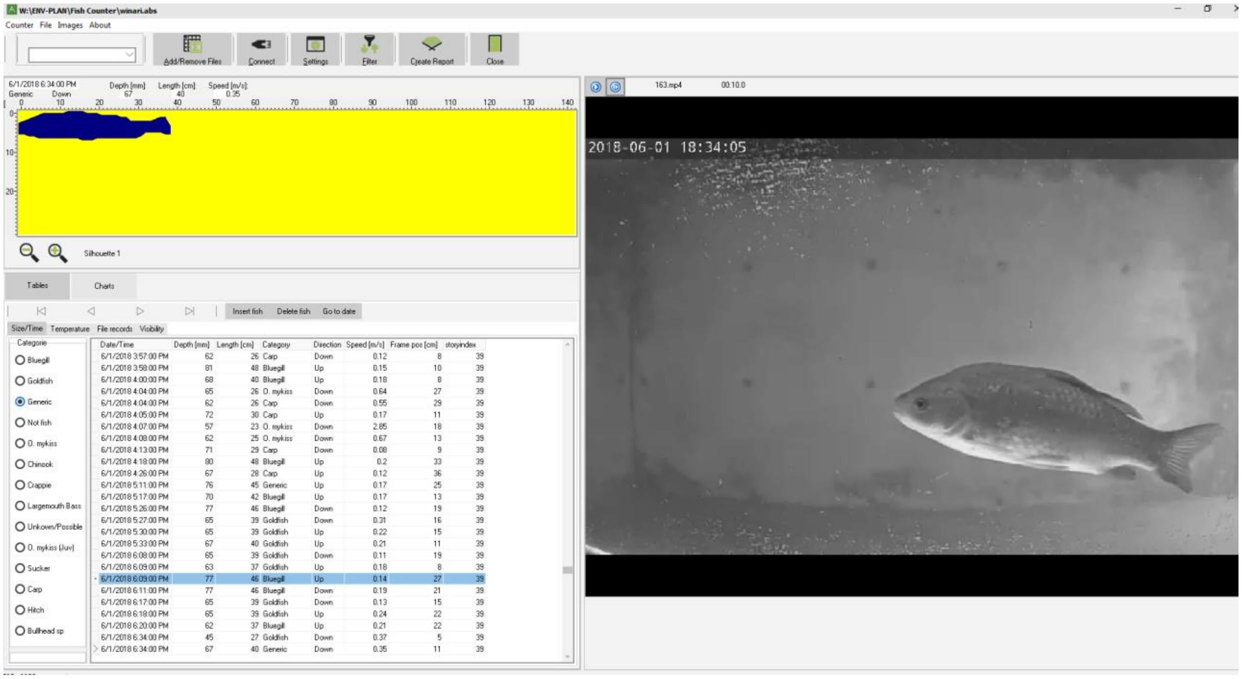
Figure 2: Vaki video image of an adult steelhead (*Oncorhynchus. mykiss*).



6/5/2018 12:44:00 PM
Carp Down
Depth [mm]: 132
Length [cm]: 55
Speed [m/s]: 0.22

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyinde
6/5/2018 12:25:00 PM	136	57	Carp	Up	0.24	29	
6/5/2018 12:35:00 PM	123	51	Carp	Down	0.14	32	
6/5/2018 12:36:00 PM	128	53	Carp	Up	0.2	23	
6/5/2018 12:37:00 PM	117	49	Carp	Down	0.12	27	
6/5/2018 12:38:00 PM	136	57	Carp	Up	0.26	27	
6/5/2018 12:41:00 PM	124	52	Carp	Down	0.22	21	
6/5/2018 12:42:00 PM	137	57	Carp	Up	0.23	11	
6/5/2018 12:44:00 PM	132	55	Carp	Down	0.22	20	
6/5/2018 12:46:00 PM	119	49	Carp	Up	0.21	15	
6/5/2018 12:49:00 PM	128	53	Carp	Down	0.21	22	
6/5/2018 12:50:00 PM	125	52	Carp	Up	0.31	18	
6/5/2018 1:03:00 PM	115	48	Carp	Down	0.18	25	
6/5/2018 1:04:00 PM	138	57	Carp	Up	0.31	20	
6/5/2018 1:11:00 PM	114	47	Carp	Down	0.13	35	
6/5/2018 1:14:00 PM	148	62	Carp	Up	0.23	9	
6/5/2018 1:16:00 PM	138	57	Carp	Down	0.18	30	
6/5/2018 1:16:00 PM	136	57	Carp	Up	0.26	29	
6/5/2018 1:24:00 PM	120	50	Carp	Down	0.16	26	
6/5/2018 1:25:00 PM	142	59	Carp	Up	0.23	31	
6/5/2018 1:30:00 PM	131	55	Carp	Down	0.35	13	
6/5/2018 1:33:00 PM	143	60	Carp	Up	0.22	12	
6/5/2018 1:34:00 PM	136	57	Carp	Down	0.16	28	
6/5/2018 1:36:00 PM	132	55	Carp	Up	0.22	17	
6/5/2018 1:38:00 PM	128	53	Carp	Down	0.17	26	
6/5/2018 1:40:00 PM	132	55	Carp	Up	0.21	22	

Figure 3: Vaki video image of a carp (*Cyprinus carpio*).

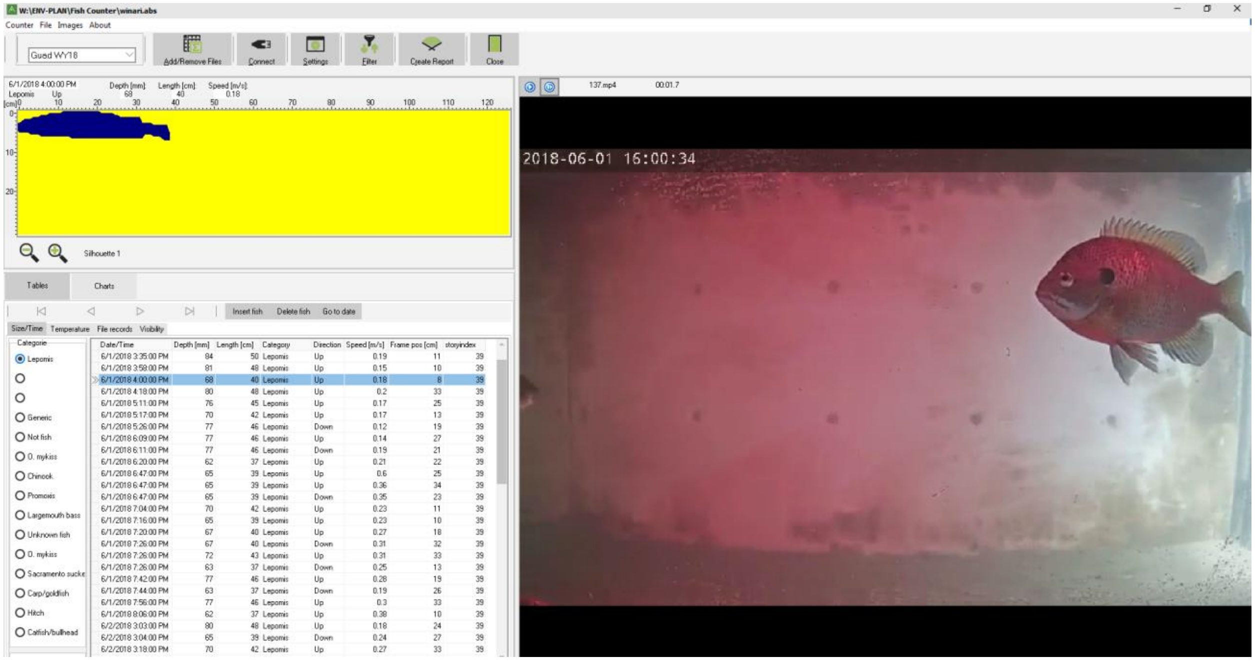


6/1/2018 6:34:00 PM
Generic Down
Depth [mm]: 67
Length [cm]: 40
Speed [m/s]: 0.35

Categorie
○ Bluegill
○ Goldfish
● Generic
○ Not fish
○ O. mykiss
○ Chinook
○ Crappie
○ Largemouth Bass
○ Unkown/Possible
○ O. mykiss (Juv)
○ Sucker
○ Carp
○ Hitch
○ Bullhead sp

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
6/1/2018 3:57:00 PM	62	26	Carp	Down	0.12	8	39
6/1/2018 3:58:00 PM	81	48	Bluegill	Up	0.15	10	39
6/1/2018 4:00:00 PM	68	40	Bluegill	Up	0.18	8	39
6/1/2018 4:04:00 PM	65	26	O. mykiss	Down	0.64	27	39
6/1/2018 4:04:00 PM	62	26	Carp	Down	0.55	29	39
6/1/2018 4:05:00 PM	72	30	Carp	Up	0.17	11	39
6/1/2018 4:07:00 PM	57	23	O. mykiss	Down	2.85	18	39
6/1/2018 4:08:00 PM	62	25	O. mykiss	Down	0.67	13	39
6/1/2018 4:13:00 PM	71	29	Carp	Down	0.08	9	39
6/1/2018 4:18:00 PM	80	48	Bluegill	Up	0.2	33	39
6/1/2018 4:26:00 PM	67	28	Carp	Up	0.12	36	39
6/1/2018 5:11:00 PM	76	45	Generic	Up	0.17	25	39
6/1/2018 5:17:00 PM	70	42	Bluegill	Up	0.17	13	39
6/1/2018 5:26:00 PM	77	46	Bluegill	Down	0.12	19	39
6/1/2018 5:27:00 PM	65	39	Goldfish	Down	0.31	16	39
6/1/2018 5:30:00 PM	65	39	Goldfish	Up	0.22	15	39
6/1/2018 5:33:00 PM	67	40	Goldfish	Up	0.21	11	39
6/1/2018 6:08:00 PM	65	39	Goldfish	Down	0.11	19	39
6/1/2018 6:09:00 PM	63	37	Goldfish	Up	0.18	8	39
6/1/2018 6:09:00 PM	77	46	Bluegill	Up	0.14	27	39
6/1/2018 6:11:00 PM	77	46	Bluegill	Down	0.19	21	39
6/1/2018 6:17:00 PM	65	39	Goldfish	Down	0.13	15	39
6/1/2018 6:18:00 PM	65	39	Goldfish	Up	0.24	22	39
6/1/2018 6:20:00 PM	62	37	Bluegill	Up	0.21	22	39
6/1/2018 6:34:00 PM	45	27	Goldfish	Down	0.37	5	39
6/1/2018 6:34:00 PM	67	40	Generic	Down	0.35	11	39

Figure 4: Vaki video image of a goldfish (*Carassius auratus*).



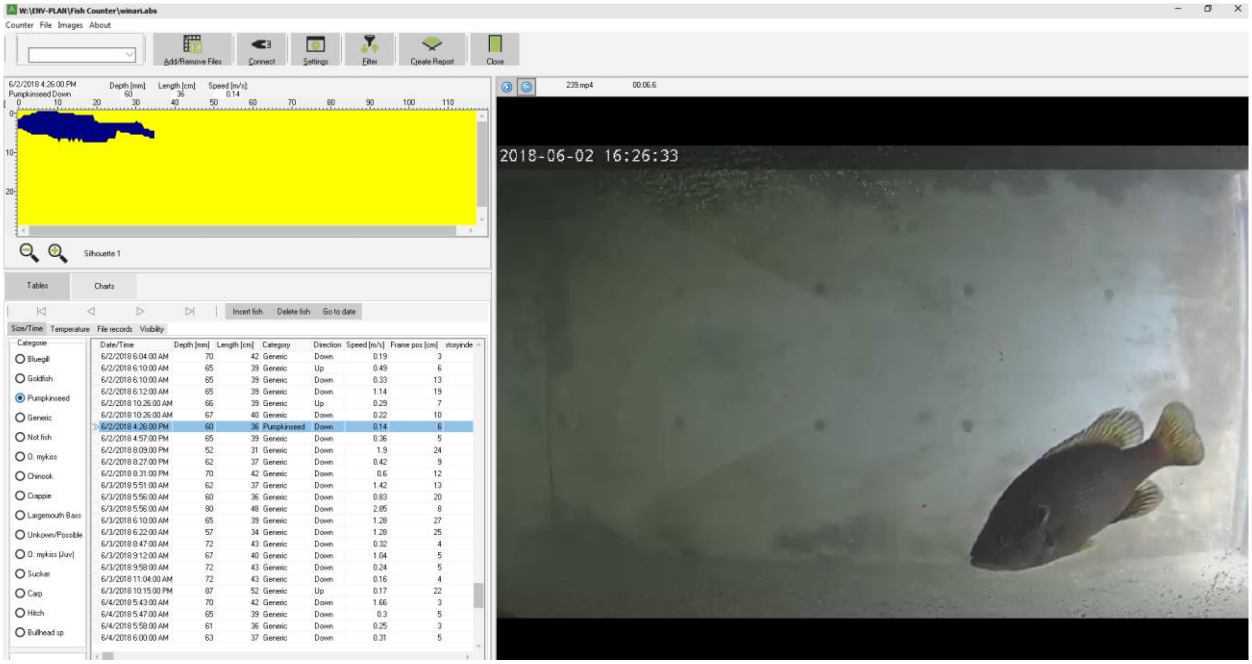
Guad WY18

6/1/2018 4:00:00 PM
Lepomis Up
Depth [mm]: 68
Length [cm]: 40
Speed [m/s]: 0.18

Categorie
● Lepomis
○
○
○ Generic
○ Not fish
○ O. mykiss
○ Chinook
○ Promoxis
○ Largemouth bass
○ Unknown fish
○ O. mykiss
○ Sacramento sucke
○ Carp/goldfish
○ Hitch
○ Catfish/bullhead

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
6/1/2018 3:35:00 PM	84	50	Lepomis	Up	0.19	11	39
6/1/2018 3:58:00 PM	81	48	Lepomis	Up	0.15	10	39
6/1/2018 4:00:00 PM	68	40	Lepomis	Up	0.18	8	39
6/1/2018 4:18:00 PM	80	48	Lepomis	Up	0.2	33	39
6/1/2018 5:11:00 PM	76	45	Lepomis	Up	0.17	25	39
6/1/2018 5:17:00 PM	70	42	Lepomis	Up	0.17	13	39
6/1/2018 5:26:00 PM	77	46	Lepomis	Down	0.12	19	39
6/1/2018 6:09:00 PM	77	46	Lepomis	Up	0.14	27	39
6/1/2018 6:11:00 PM	77	46	Lepomis	Down	0.19	21	39
6/1/2018 6:20:00 PM	62	37	Lepomis	Up	0.21	22	39
6/1/2018 6:47:00 PM	65	39	Lepomis	Up	0.6	25	39
6/1/2018 6:47:00 PM	65	39	Lepomis	Up	0.36	34	39
6/1/2018 6:47:00 PM	65	39	Lepomis	Down	0.35	23	39
6/1/2018 7:04:00 PM	70	42	Lepomis	Up	0.23	11	39
6/1/2018 7:16:00 PM	65	39	Lepomis	Up	0.23	10	39
6/1/2018 7:20:00 PM	67	40	Lepomis	Up	0.27	18	39
6/1/2018 7:26:00 PM	67	40	Lepomis	Down	0.31	32	39
6/1/2018 7:26:00 PM	72	43	Lepomis	Up	0.31	33	39
6/1/2018 7:26:00 PM	63	37	Lepomis	Down	0.25	13	39
6/1/2018 7:42:00 PM	77	46	Lepomis	Up	0.28	19	39
6/1/2018 7:44:00 PM	63	37	Lepomis	Down	0.19	26	39
6/1/2018 7:56:00 PM	77	46	Lepomis	Up	0.3	33	39
6/1/2018 8:06:00 PM	62	37	Lepomis	Up	0.38	10	39
6/2/2018 3:03:00 PM	80	48	Lepomis	Up	0.18	24	39
6/2/2018 3:04:00 PM	65	39	Lepomis	Down	0.24	27	39
6/2/2018 3:18:00 PM	70	42	Lepomis	Up	0.27	33	39

Figure 5: Vaki video image of a bluegill (*Lepomis macrochirus*; classified as *Lepomis spp*).



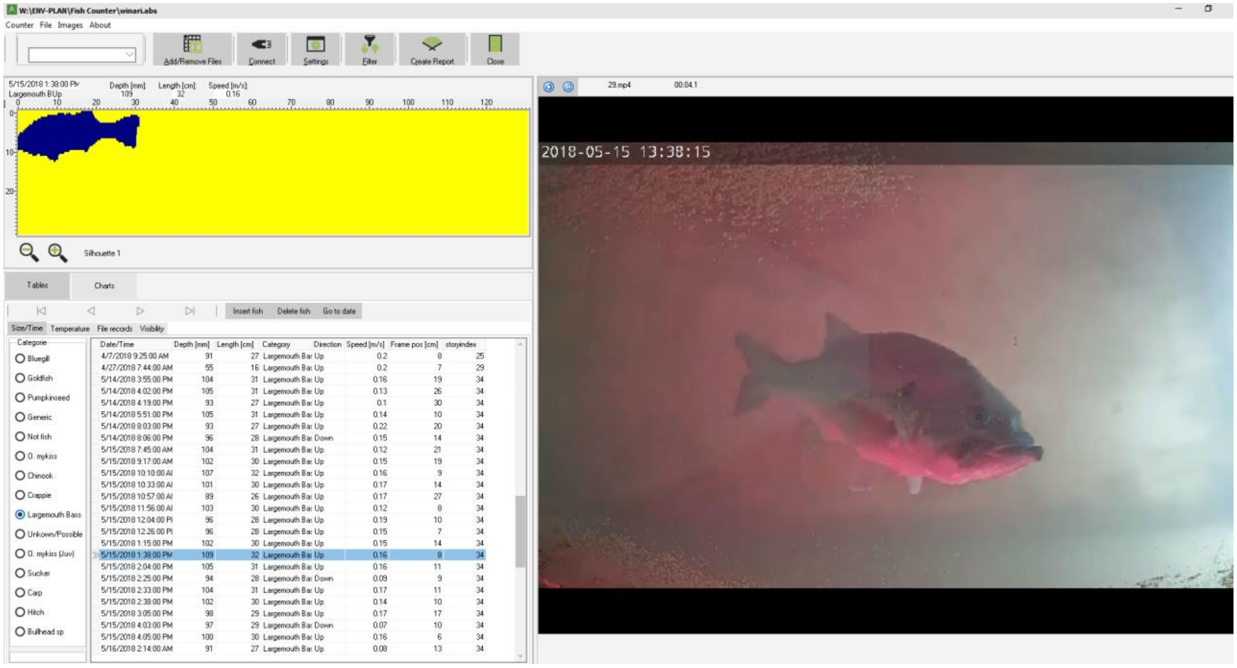
6/2/2018 4:26:00 PM
Pumpkinseed Down

Depth [mm]: 60
Length [cm]: 36
Speed [m/s]: 0.14

Categorie
○ Bluegill
○ Goldfish
● Pumpkinseed
○ Generic
○ Not fish
○ O. mykiss
○ Chinook
○ Crappie
○ Largemouth Bass
○ Unkown/Possible
○ O. mykiss (Juv)
○ Sucker
○ Carp
○ Hitch
○ Bullhead sp

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyinde
6/2/2018 6:04:00 AM	70	42	Generic	Down	0.19	3	
6/2/2018 6:10:00 AM	65	39	Generic	Up	0.49	6	
6/2/2018 6:10:00 AM	65	39	Generic	Down	0.33	13	
6/2/2018 6:12:00 AM	65	39	Generic	Down	1.14	19	
6/2/2018 10:26:00 AM	66	39	Generic	Up	0.29	7	
6/2/2018 10:26:00 AM	67	40	Generic	Down	0.22	10	
6/2/2018 4:26:00 PM	60	36	Pumpkinseed	Down	0.14	6	
6/2/2018 4:57:00 PM	65	39	Generic	Down	0.36	5	
6/2/2018 8:09:00 PM	52	31	Generic	Down	1.9	24	
6/2/2018 8:27:00 PM	62	37	Generic	Down	0.42	9	
6/2/2018 8:31:00 PM	70	42	Generic	Down	0.6	12	
6/3/2018 5:51:00 AM	62	37	Generic	Down	1.42	13	
6/3/2018 5:56:00 AM	60	36	Generic	Down	0.83	20	
6/3/2018 5:56:00 AM	80	48	Generic	Down	2.85	8	
6/3/2018 6:10:00 AM	65	39	Generic	Down	1.28	27	
6/3/2018 6:22:00 AM	57	34	Generic	Down	1.28	25	
6/3/2018 8:47:00 AM	72	43	Generic	Down	0.32	4	
6/3/2018 9:12:00 AM	67	40	Generic	Down	1.04	5	
6/3/2018 9:58:00 AM	72	43	Generic	Down	0.24	5	
6/3/2018 11:04:00 AM	72	43	Generic	Down	0.16	4	
6/3/2018 10:15:00 PM	87	52	Generic	Up	0.17	22	
6/4/2018 5:43:00 AM	70	42	Generic	Down	1.66	3	
6/4/2018 5:47:00 AM	65	39	Generic	Down	0.3	5	
6/4/2018 5:58:00 AM	61	36	Generic	Down	0.25	3	
6/4/2018 6:00:00 AM	63	37	Generic	Down	0.31	5	

Figure 6: Vaki video image of a green sunfish (*Lepomis cyanellus*; classified as *Lepomis spp*).



5/15/2018 1:38:00 PM
Largemouth BUp

Depth [mm]: 109
Length [cm]: 32
Speed [m/s]: 0.16

Categorie
○ Bluegill
○ Goldfish
○ Pumpkinseed
○ Generic
○ Not fish
○ O. mykiss
○ Chinook
○ Crappie
● Largemouth Bass
○ Unkown/Possible
○ O. mykiss (Juv)
○ Sucker
○ Carp
○ Hitch
○ Bullhead sp

Date/Time	Depth [mm]	Length [cm]	Category	Direction	Speed [m/s]	Frame pos [cm]	storyindex
4/7/2018 9:25:00 AM	91	27	Largemouth Ba:	Up	0.2	8	25
4/27/2018 7:44:00 AM	55	16	Largemouth Ba:	Up	0.2	7	29
5/14/2018 3:55:00 PM	104	31	Largemouth Ba:	Up	0.16	19	34
5/14/2018 4:02:00 PM	105	31	Largemouth Ba:	Up	0.13	26	34
5/14/2018 4:19:00 PM	93	27	Largemouth Ba:	Up	0.1	30	34
5/14/2018 5:51:00 PM	105	31	Largemouth Ba:	Up	0.14	10	34
5/14/2018 8:03:00 PM	93	27	Largemouth Ba:	Up	0.22	20	34
5/14/2018 8:06:00 PM	96	28	Largemouth Ba:	Down	0.15	14	34
5/15/2018 7:45:00 AM	104	31	Largemouth Ba:	Up	0.12	21	34
5/15/2018 9:17:00 AM	102	30	Largemouth Ba:	Up	0.15	19	34
5/15/2018 10:10:00 AI	107	32	Largemouth Ba:	Up	0.16	9	34
5/15/2018 10:33:00 AI	101	30	Largemouth Ba:	Up	0.17	14	34
5/15/2018 10:57:00 AI	89	26	Largemouth Ba:	Up	0.17	27	34
5/15/2018 11:56:00 AI	103	30	Largemouth Ba:	Up	0.12	8	34
5/15/2018 12:04:00 PI	96	28	Largemouth Ba:	Up	0.19	10	34
5/15/2018 12:26:00 PI	96	28	Largemouth Ba:	Up	0.15	7	34
5/15/2018 1:15:00 PM	102	30	Largemouth Ba:	Up	0.15	14	34
5/15/2018 1:38:00 PM	109	32	Largemouth Ba:	Up	0.16	8	34
5/15/2018 2:04:00 PM	105	31	Largemouth Ba:	Up	0.16	11	34
5/15/2018 2:25:00 PM	94	28	Largemouth Ba:	Down	0.09	9	34
5/15/2018 2:33:00 PM	104	31	Largemouth Ba:	Up	0.17	11	34
5/15/2018 2:38:00 PM	102	30	Largemouth Ba:	Up	0.14	10	34
5/15/2018 3:05:00 PM	98	29	Largemouth Ba:	Up	0.17	17	34
5/15/2018 4:03:00 PM	97	29	Largemouth Ba:	Down	0.07	10	34
5/15/2018 4:05:00 PM	100	30	Largemouth Ba:	Up	0.16	6	34
5/16/2018 2:14:00 AM	91	27	Largemouth Ba:	Up	0.08	13	34

Figure 7: Vaki video image of a Largemouth bass (*Micropterus salmoides*).